



High resolution mapping of non-patterned MRAM film stacks

Kjær, Daniel; Henrichsen, Henrik Hartmann; Chenchu, Jacob Wang ; Hansen, Ole; Nielsen, Peter Folmer; Petersen, Dirch Hjorth

Published in:
58th Annual Conference on Magnetism and Magnetic Materials

Publication date:
2013

[Link back to DTU Orbit](#)

Citation (APA):
Kjær, D., Henrichsen, H. H., Chenchu, J. W., Hansen, O., Nielsen, P. F., & Petersen, D. H. (2013). High resolution mapping of non-patterned MRAM film stacks. In *58th Annual Conference on Magnetism and Magnetic Materials: Abstracts*

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

High resolution mapping of non-patterned MRAM film stacks

Authors: Daniel Kjaer, Henrik Hartmann Henrichsen, Jacob Wang Chenchen, Ole Hansen, Peter Folmer Nielsen and Dirch Hjorth Petersen

The need for suitable metrology is increasing as the industry moves towards actual volume production of MRAM and starts focusing on sample homogeneity and other performance related factors [1]. To identify the usable area of a wafer is of fundamental importance in a production environment. The defining parameters of magnetic tunnel junctions (MTJ) are the resistance-area product (RA) and magnetoresistance (MR). For the past decade, the Current In-Plane Tunneling (CIPT) technique [2] has been the standard method to characterize these parameters. Due to CIPT measurement time (~ 2 min./pt.) the technique is generally not used for full wafer analysis with high spatial resolution.

We present CIPT line scans and high density area mapping (see fig. 1) revealing variations of RA and MR far exceeding acceptable process variations ($\pm 10\%$). We demonstrate that the information from line scans alone is insufficient to define an optimal edge exclusion zone, as this would lead to significant loss of otherwise usable wafer area. In order to define the optimal edge exclusion zone, high density mapping is needed to map tool process variability.

We find that variations in RA is the most critical process parameter as compared to the variations of MR (see fig. 2), and propose the necessary information can be obtained purely by measuring RA. This reduces the measurement time by at least a factor of 3. Further reduction of the measurement time is obtained by optimization of the number of samplings per measurement point. MR control measurements may still be required, but since the MR variability is generally insignificant as compared to the variability in RA, high resolution MR mapping is not necessary.

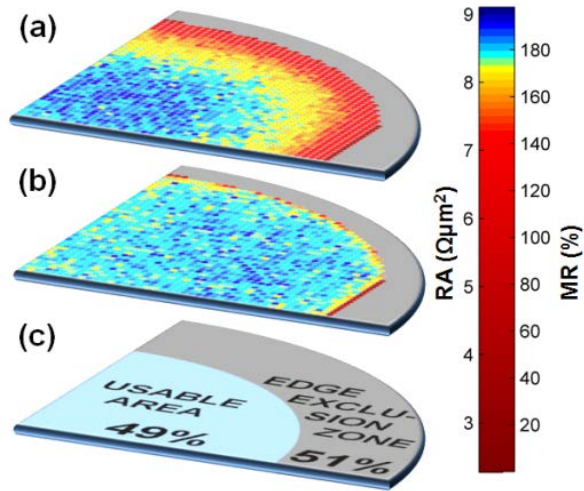


Fig. 1. High density mapping of RA (a) and MR (b) obtained with 2 mm step size on a quarter of a 200 mm wafer. (c) The usable wafer area vs. edge exclusion zone based on an acceptance limit of $\pm 10\%$ with respect to the mean value at the center of the wafer.

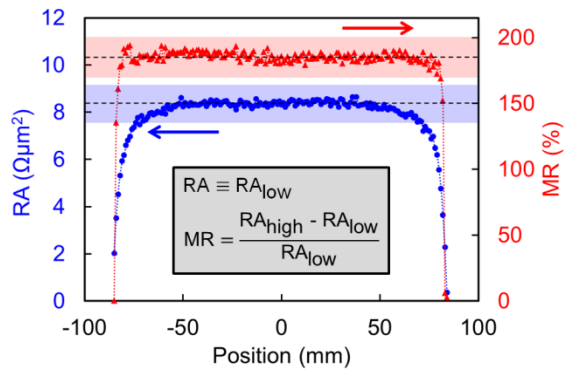


Fig. 2. Line scan measuring RA and MR with a step size of 1 mm across a 200 mm wafer. The colored areas behind the plots mark a $\pm 10\%$ band with respect to the mean values pointed out by the dashed lines. The insert shows the definition of RA together with the formula for MR.

Keywords: Magnetic tunnel junction, four-point probe resistance measurements, magnetoresistance, MRAM.

References:

- [1] J. Shi, Ultrathin Magnetic Structures IV, (Springer-Verlag, Berlin Heidelberg 2005), p. 188.
- [2] D. C. Worledge and P. L. Trouilloud, Appl. Phys. Lett. 83, 84-86 (2003).